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# Bladelet cores as weapon tips? Hafting residue identification and micro-wear analysis of three carinated burins from the late Aurignacian of Les Vachons, France

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## Abstract

The interpretation of Upper Palaeolithic carinated lithic forms as discarded cores from the production of bladelets is now well established and the weight of evidence to support this indisputable. However, it is also clear that the relationships between lithic typology, technology and function are complex. Presented here are micro-wear analyses of three carinated burins from the late Aurignacian level of Les Vachons, France. The remains of birch pitch adhering to the artefacts are clear evidence that they were hafted; the first time this material has been identified on Aurignacian artefacts. Thus, while the techno-morphology of the artefacts is consistent with their role as bladelet cores our results indicate that they functioned as hafted tools. Unlike other Middle and Upper Palaeolithic industries the Aurignacian is not thought to include (non-bladelet) lithic weapon tips. However, due to patterns of use-wear present on two of the artefacts we suggest that this was their most plausible hafted function.

## Keywords

Hafting residues, Micro-wear, Lithic technology, Lithic function, Aurignacian, Early Upper Palaeolithic

## 1. Introduction: the Aurignacian and carinated burins

The Aurignacian (c.38–29,000 BP) is the first Europe-wide Upper Palaeolithic archaeological entity and is interpreted by many as the archaeological signature of the first anatomically modern humans to occupy the continent (e.g. Conard and Bolus, 2003; Davies, 2001; Jacobi and Pettitt, 2000; Mellars, 2005; Pettitt, 2008; Stringer, 2006). Over the past decade numerous publications have detailed the technology of various carinated lithic artefacts ubiquitous in Aurignacian space and time (e.g. Chiotti, 2000, 2003; Dinnis, 2008; Flas et al., 2006; Hays and Lucas, 2001; Le Brun- Ricalens et al., 2005, 2006; Lucas, 1997; Pesesse and Michel, 2006). This work has demonstrated that many of these artefacts (thick nosed scrapers, *burins busqués* etc.) served first as cores for the production of small and regular bladelets. The complexity of their final form results from the standardisation of reduction technique applied to detach particular desired bladelet forms.

Two such discarded core artefacts abundant within the late Aurignacian of western Europe are *burins busqués* (see Flas et al., 2006) and *burins des Vachons* (see Pesesse and Michel 2006). However, traces of use on examples of both artefacts indicate that they were also sometimes utilised as tools: *burins des Vachons* from the Italian sites of San Cassiano (Arezzo) and Caruso (Foggia) have significant wear traces indicative of their use as engraving tools (Arrighi et al., 2006); and 33 *burins busqués* from Abri Pataud (level 7 lower) (Dordogne, France) bear polish on one or both margins (i.e. not on or around the burin bit) presumably relating to their use as tools (Chiotti, 2005: 251). Unsurprisingly lithic material in the Aurignacian has therefore been used in a flexible way, with each blank/artefact serving different functional requirements during its reduction and use.

Here, we present the results of microscopic use-wear and energy-dispersive X-ray (EDX) analyses of three carinated burins from the late Aurignacian level 2 of the southwest central French site of Les Vachons. Given the form of these artefacts (close to *busqué/Vachons*-type burins) they were likely to have been used for the production of bladelets. However, our analyses also show the clear presence of hafting residues demonstrating that, at some point during their respective histories, they were hafted. With regard to the examples above, this is significant; taking the reports of the core artefacts from San Cassiano, Caruso and Abri Pataud at face value, artefacts there appear to have been used expediently (i.e. handheld). Conversely, the three artefacts from Les Vachons presented here were demonstrably processed and formed the active part of a composite technology, comprising a shaft, birch pitch used as mastic and the stone tool itself. In addition, we tentatively interpret the artefacts' function. Our use-wear results indicate that they were not utilised as engraving tools. Instead, two of them appear to have been used as hafted weapon points. While many Aurignacian assemblages contain osseous points, the authors are unaware of any (non-bladelet) lithic points in other assemblages.

## 2. Use-wear analysis and birch pitch identification

Since Sergej A. Semenov's pioneering work in the 1950s (Semenov, 1964) microscopic use-wear analysis has been adopted and developed by a number of lithic archaeologists (e.g. Anderson, 1980; Hayden, 1979; Kamminga, 1977; Keeley, 1980; Odell and Odell-Vereecken, 1980; Plisson, 1985; Unrath, 1982; Unrath et al., 1986; Vaughan, 1985; and many others). Working from a pool of data accrued via experimental imitation of presumed prehistoric working activities using replicas of lithic artefacts, analysts are able to identify wear patterns and surface alterations on lithic artefacts found in the archaeological record. Macro- and microscopic comparison of wear traces on experimental and archaeological lithic material allows the likely function(s) of the latter to be determined.

With specific regard to hafted weapon tips, two broad forms of use-wear have been consistently shown to be significant in diagnosis: impact scars and superficial striations.

The result of forceful longitudinal collision, impact scars are the negatives of frontal bending fractures that terminate with step or hinge terminations at the tip of projectile points (e.g. Fischer et al., 1984; Lombard, 2005a,b; Lombard and Pargeter, 2008) or the negatives of fractures that resemble burin blows occurring along either one of the lateral edges, but lacking the negative bulb of percussion common to deliberate burination (Barton and Bergman, 1982; Lombard, 2005b). Similar scars observed on the opposite (hafted) end of projectile implements have been attributed to reacting forces of the shaft upon impact (Pawlik, 1997).

Relatively uncommon on archaeological artefacts, superficial striations are likewise an indicator of forceful frontal impact when positioned longitudinally along the axis of the impact and penetration of the tip. In this case, they are usually positioned slightly away from – rather than at – the tip (Lombard, 2005a). Comprehensive experimental study by Fischer et al. (1984) has recognised these striations as a diagnostic feature of projectile points, concluding that impact with bone creates sufficient kinetic energy and friction to produce these linear polishes.

Both of these use-wear traces have been identified on lithic artefacts from various prehistoric assemblages, and particularly on artefacts whose morphology had already suggested use as a weapon tip (e.g. Levallois points, Solutrean points, Neolithic arrow points) (Geneste and Plisson, 1993; Hardy et al., 2001; Pawlik, 1995: 128ff; Pawlik and Thissen, 2008; Shea, 1988).

The process of hafting itself causes (albeit weak) wear traces on the hafted artefacts and these are often neglected in micro-wear analysis. Wear traces characteristic of hafting include: clusters of fractures on the edges of the hafted section of the artefact, and polishing of the micro-topography (e.g. dorsal ridges) also limited to the hafted area and resulting from minor movements of the tool within the shaft (Keeley, 1982; Lombard, 2005a; Pawlik, 1995, 2004a; Rots, 2003).

In addition to invasive traces of wear visible on the tool's surface, identification of residues adhering to the artefact is integral to the reconstruction of past activities. Residues from worked materials (e.g. blood, starch grains, phytoliths, epidermal tissue, parenchyma, ochre, pyrite etc.) remain sometimes – although not frequently – on the artefact's functional parts. Approaches to the identification of these residues have been discussed by a number of authors (e.g. Fullagar, 1998; Gechter-Jones and Pawlik, 1998; Hardy and Garufi, 1998; Pawlik, 2004b; Haslam, 2006; Lombard, 2005a; Loy, 1983, 1990; Rots and Williamson, 2004; Torrence and Barton, 2006).

Residues not only originate from the contact or working material but also from the tool's hafting and handling. Microscopic examination of Mesolithic and Upper Palaeolithic artefacts from various sites in Austria and Germany revealed blackish residues that occurred in many cases on the potential hafted area, rather than along the functional edges (Baales, 2002; Kind, 1997; Pawlik, 1997; Schäfer et al., 2006). These residues were just a few micro-metres in size and too small for standard chemical analysis. Analysis comprising optical microscopy, scanning electron microscopy (SEM) and EDX allowed the elementary composition of the residue to be documented and – with reference to experimentally created samples and samples from Neolithic sites in Germany and Switzerland – the material identified as birch pitch (Pawlik, 1995, 2004a). This work led to the identification of these residues as the remains of hafting mastic (Rottländer, 1991).

This combination of optical microscopy, SEM and EDX– used within this study– has previously proved ideal for successful identification of birch pitch residues (Kind, 1997; Pawlik, 1995, 2004a,b). The method permits a precise 'point and shoot' element and can be applied to samples only a few micrometres in size under live view conditions. Furthermore, and important when dealing with collections of historical as well as archaeological importance, it is a non-invasive method.

Archaeological evidence— at least for Europe— exists only for adhesives deriving from birch (Weiner, 2005: 20). Birch pitch is the oldest known synthetically produced material and its use as an adhesive has already been recognised as early as the Middle Palaeolithic (e.g. at Altdorf, Campitello, Königsau) (Grünberg, 2002; Koller et al., 2001; Mazza et al., 2006; Pawlik and Thissen, 2008). Its production entails the heating of rolls of birch bark in an oxygen-free atmosphere causing the bark to transform completely into a liquid pitch. While distillation of birch pitch using a retort is known to have been practiced since the 10th century AD (Weiner, 1988), prehistoric evidence for this method, even during the Neolithic, is remarkably absent (Weiner, 1991).

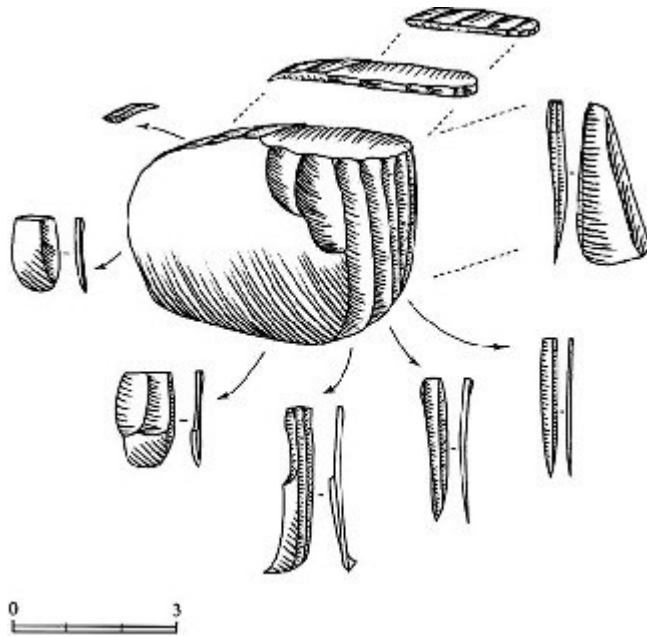


Figure 1 Schematic diagram of the reduction of a thick flake using the late Aurignacian *burin des Vachons* technique. The platform from which the bladelet will be produced is formed by a burin removal (top). A series of initial ventral removals (bottom and bottom left) are made in order to regulate the shape and scar pattern of the blank, and therefore the precise morphology of the desired end product: a long, thin, regular bladelet (bottom right). (Figure modified from Pesesse and Michel, 2006: 150 – permission to use figure given by D. Pesesse.)

Obviously, ceramic retorts cannot have been used during the Palaeolithic. Instead, experimental work has indicated that prehistoric birch pitch could have been produced by using a narrow pit in the ground as the ‘retort’ (Palmer, 2007; Pawlik, 1995, 2004a). The lit birch bark is placed into the pit, causing the removal of oxygen from its immediate surroundings, and allowing the pitch to ‘sweat out’. This sticky liquid can be applied immediately as hafting mastic. One characteristic of birch pitch formed in this way is the presence of unaltered primary plant matter embedded in the amorphous matrix. This can be detected under the SEM (Pawlik, 1995: 209-211).

An unusual artefact from the Mesolithic site of Henauhof-Nord II in southwest Germany supports this proposed method of production: a quantity of birch bark wrapped around a central core made of small pebbles and clay (Kind, 1997: 102). Micro-wear analysis of the Henauhof-Nord II lithic assemblage, along with the presence of several hearths, has led to the site being interpreted as a hafting and retooling site (Pawlik, 1997). It therefore appears that at Henauhof-Nord II this birch wrap was a preparation for the production of pitch.

### 3. The Aurignacian of Les Vachons

The site of Les Vachons lies on a tributary of the Boëme River (itself a tributary of the Charente) in the south central French département of Charente. The site comprises two rock shelters that have

yielded Early and Mid Upper Palaeolithic material and a cave that has yielded Mid Upper Palaeolithic archaeology only.

In the decades before 1929 excavations of the cave deposits and the rock shelters were carried out by Coiffard. Between 1929 and 1937 further work was undertaken at both rock shelters by Bouyssonie, in conjunction with Coiffard. (Bouyssonie and de Sonnevile-Bordes, 1956; Perpère, 1972, 1977). As a result of the work of Bouyssonie, five archaeological levels consistent between both rock shelters were identified (Bouyssonie, 1948; Bouyssonie and de Sonnevile-Bordes, 1956; Perpère, 1977). Of these, the lowermost two are Aurignacian.

The lithic assemblage from the basal level 1 is dominated by retouched blades and scrapers (including carinated forms) with very few burins, and contains a split-based osseous point. The overlying level 2 contains a higher proportion of dihedral and carinated burins and the presence of numerous *burins busqués* and *burins des Vachons* demonstrates its later Aurignacian age. Regionally, these levels have been placed into a middle and late phase of the Aurignacian respectively (Dujardin, 2005). With reference to the well-understood Aurignacian sequence from southern France the two levels can be satisfactorily described respectively as Early and Recent Aurignacian (*sensu* Bordes, 2006).

#### 4. Artefacts analysed

Ubiquitous within the collections from level 2 from both rock shelters at Les Vachons are a series of lithic artefacts bearing a burin scar (more often than not dorsally orientated) that has subsequently been used as the platform for several burin/ventrally orientated removals. These secondary removals leave a ventrally visible carinated area. First described formally by Perpère (1972) as a distinct artefact group, *burins des Vachons* are certainly present in late Aurignacian assemblages throughout the south of France (Pesesse and Michel, 2006), in Italy to the east (Arrighi et al., 2006) and in Belgium to the north (Otte, 1979). Within southern France at least they are found only within the latest Aurignacian levels (Pesesse and Michel, 2006). Recently, Pesesse and Michel (2006) have studied *burins des Vachons* from a portion of the Les Vachons collection. Their conclusion that the artefacts are discarded cores from the systematic production of bladelets is convincing: see Fig.1.

Following the descriptions of Pesesse and Michel, the assemblage from Les Vachons level 2 contains *burins des Vachons*, “[burins busqués] à tendance Vachons” (Pesesse and Michel, 2006: 151), typical *burins busqués* and more standard carinated burins. Three artefacts whose techno-morphology resembles ‘burins busqués à tendance Vachons’ in the Henri-Martin collection (part of the Coiffard collection) at the Institut de Paléontologie Humaine (Paris) were chosen for micro-wear analysis due to a consistency in their form (two of which are detailed below and in Figs. 2 and 8: Va2c2 309 and Va2c2 320); unlike most carinated burins from the site they appeared ‘over-engineered’ to be simple discarded bladelet cores. In addition, three more standard burins were also chosen for comparison. All six have been made on flint and are therefore particularly suitable for the identification of use-wear traces (see Lombard, 2005a: 288).

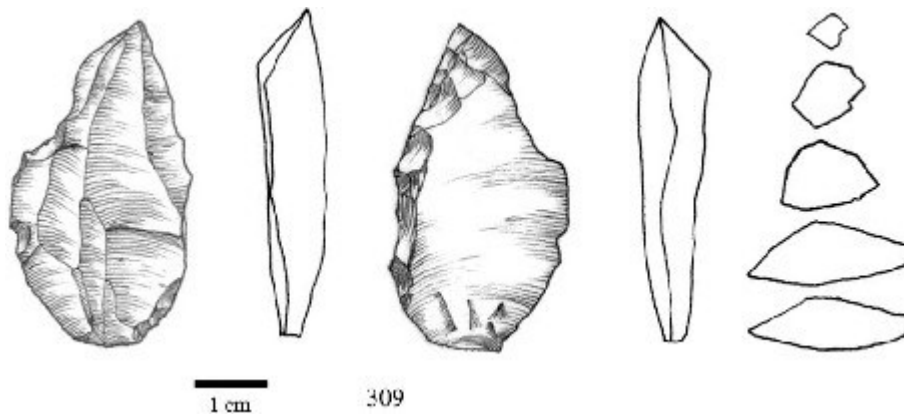


Figure 2 Va2c2 309: Dorsal, ventral and profile views. The cross-sections to the right are those at (from top to bottom) 5, 10, 25, 50 and 75 percent of the length of the artefact from its distal point. Illustration by Angeliki Theodoropoulou.

The six selected burins were subjected to microscopic use-wear analysis applying the low-power method using a zoom-stereomicroscope Olympus SZX-9 with a magnification of 6–57x and the high-power method using a reflected-light microscope Olympus BXFM-LWD with differential-interference-contrast attachment and 100–500x magnification. The microphotographs were taken with a Canon Powershot A80 digital camera and Promicron microscope adapter. The artefacts and detected residues then underwent closer inspection under a scanning electron microscope TESCAN VEGA II LSU with BSE-Detector in connection with an EDX-system BRUKER AXS XFlash Silicon Drift Detector 4030. With regards to their supposed nature, operation in low vacuum mode was chosen to avoid sputtering the samples. Sputtering is usually applied on non-conductive objects to deposit a thin layer of conductive material like carbon or gold–palladium. The conductive layer prevents the accumulation of static electric fields at the specimen due to the electron irradiation required during imaging and enables better conductivity while imaging samples. However, the possibility that a carbon coating could falsify the EDX measurements of the residue samples while a gold–palladium coating, being chemically more aggressive, could cause damage to or alter the specimens' elementary signature led to the decision to avoid the sputtering preparation and accept instead a slight reduction in image contrast and quality but take full advantage of the X-ray micro-probing EDX.

Only three burins were suitable for both low- and high-power analysis. Perhaps due to the heavily patinated surfaces on two artefacts (Va1c2 346 and Va2c2 359), no developed use-wear or any residues could be observed. Va1c1 233 was contaminated by spilled black ink on the burin tip and also the remains of insect cocoons. It was therefore excluded from the micro-wear study.

## 5. Results of analyses

### 5.1. Va2c2 309

Va2c2 309 was created on the proximal segment of a uniform (blade?) blank with a small, flat platform still present proximally (see Fig. 2). A dorsally orientated burin scar resulting from a removal struck from the distal end lies to the right of the artefact in dorsal view. Struck from this scar are a series of removals, mostly visible ventrally. The larger and more distally positioned of these scars are reminiscent of the preparation applied to *burins des Vachons* in order to modify the morphology of a subsequently struck bladelet removal close to the tip (compare Figs. 1 and 2). The ventral morphology of the distal part of the artefact is therefore consistent with its use in bladelet



creation. As a result of these removals, distally the artefact terminates to a 'point', with a 'rounded' cross-section tapering to this point (Fig. 2).

Unlike the *burin des Vachons chaîne opératoire* described by Pesesse and Michel (2006) the ventral removals on Va2c2 309 continue down almost the entire length of the right margin (left in ventral view in Fig. 2). It is difficult to see how the more proximal retouches relate to the deliberate ventral core modification seen distally in *burins des Vachons* (Fig. 1). Instead, these may have been applied to shape the artefact. The presence and positioning of a retouched concavity on the left side (in dorsal view – right in ventral) lying at the termination of the most distal ventrally orientated removal scars is reminiscent of the notch used to regulate the length of detached bladelets on typical *burins busqués*.

The artefact (see Fig. 3 top) shows along its proximal part a unilateral edge retouch with step scalar scars and second-edgerow on ventral (Fig. 3, sector A: Fig. 4a) together with an irregular pattern of scars and breaks along the opposite edge (Fig. 3, sector B: Fig. 4b). The latter provides the edge with a denticulate appearance. A slight edge rounding was noted. The immediate tip is microfractured and its structure shattered, obviously by a dynamic frontal impact (Fig. 3, sector C: Fig. 4c). The burin facet (Fig. 3, sector D: Fig. 4d) seems to correspond with a ventral reduction caused by several hinge scars (Fig. 3, sector E: Fig. 4e). Both measures could have served for the rejuvenation of the tip and the creation of a thin, rhomboid cross-section of the pointed distal end. Despite the patination of the tool's surface hampering the high-power analysis numerous residues were found along the proximal half of the tool, especially on the dorsal face (Fig. 3, pos. 2–5: Fig. 4h; Fig. 5a–c). They are associated with signs of abrasion in the form of a highly reflecting micro-polish on elevated parts of the artefact's micro-topography, such as the dorsal ridges and the bulb of percussion (Fig. 3, pos. 1, 6: Fig. 4g–h; Fig. 5d). The presence and positioning of these micro-wear traces and residues indicate that the artefact was hafted and that the hafted area included the entire proximal half of the artefact (Fig. 3, pos. 7: Fig. 5e). No polishes or edge wear indicative of use as an engraving tool (e.g. see Pawlik, 1992: 72ff) are apparent at the tip. The use of the artefact as an engraving tool is therefore extremely unlikely.



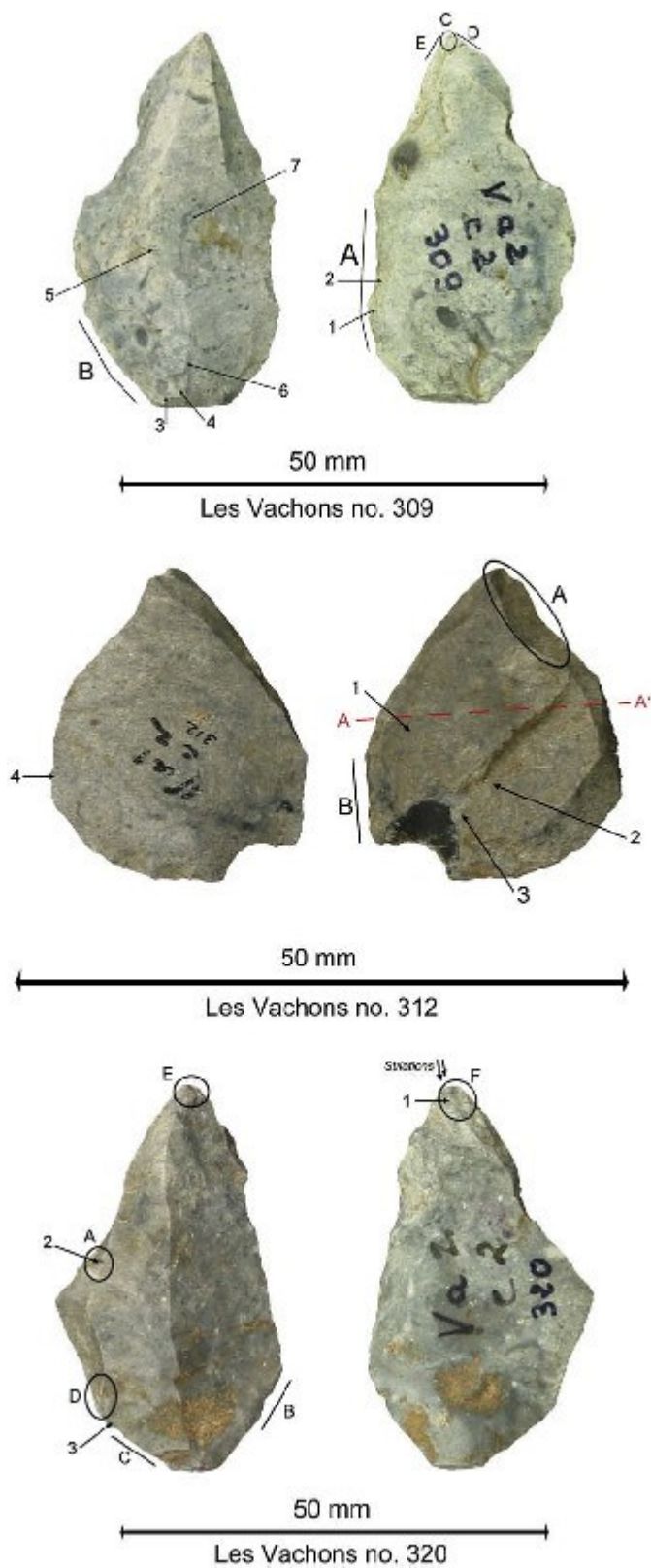


Figure 3 Locations and numbers of observed wear traces and residues on Va2c2 309, Va1c2 312 and Va2c2 320.

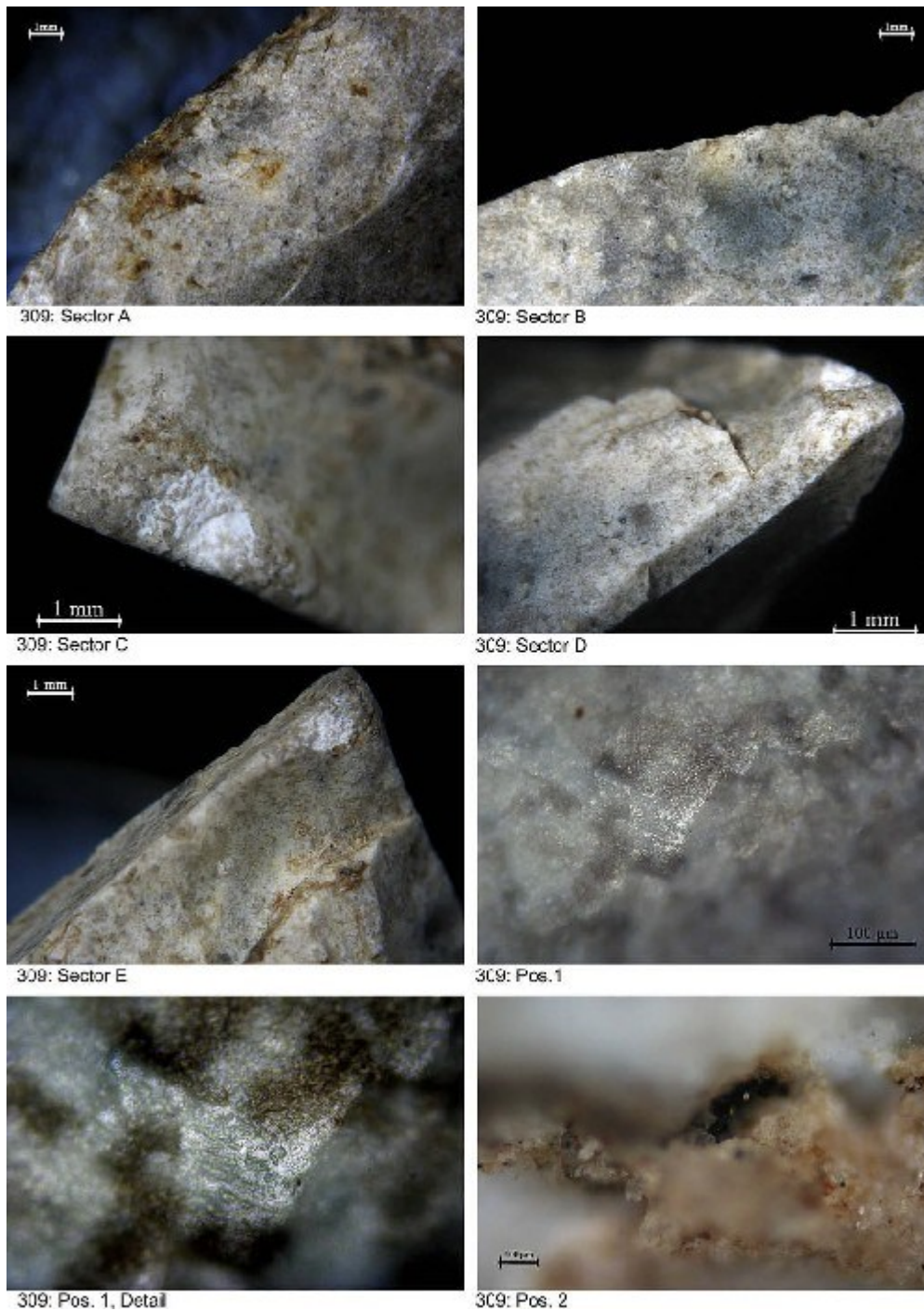


Figure 4 Micro-wear traces and residues on Va2c2 309.

## 5.2. Va1c2 312

Va1c2 312 (see Fig. 6) is made on a less regular blank than Va2c2 309 (above) and Va2c2 320 (below). The area of a concave 'burin' scar lying to the right (dorsal view) has been used as the platform for subsequent removals, the most prominent lying ventrally. This larger removal scar is consistent with the deliberate production of bladelet débitage.



Figure 5 Micro-wear traces and residues on Va2c2 309 and Va1c2 312.

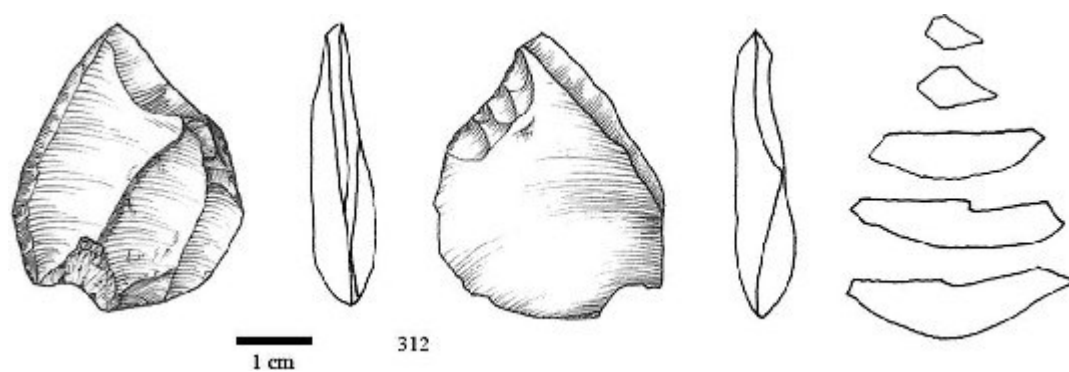


Figure 6 Va1c2 312: Dorsal, ventral and profile views. Cross-sections as in Fig. 2. Illustration by Angeliki Theodoropoulou.



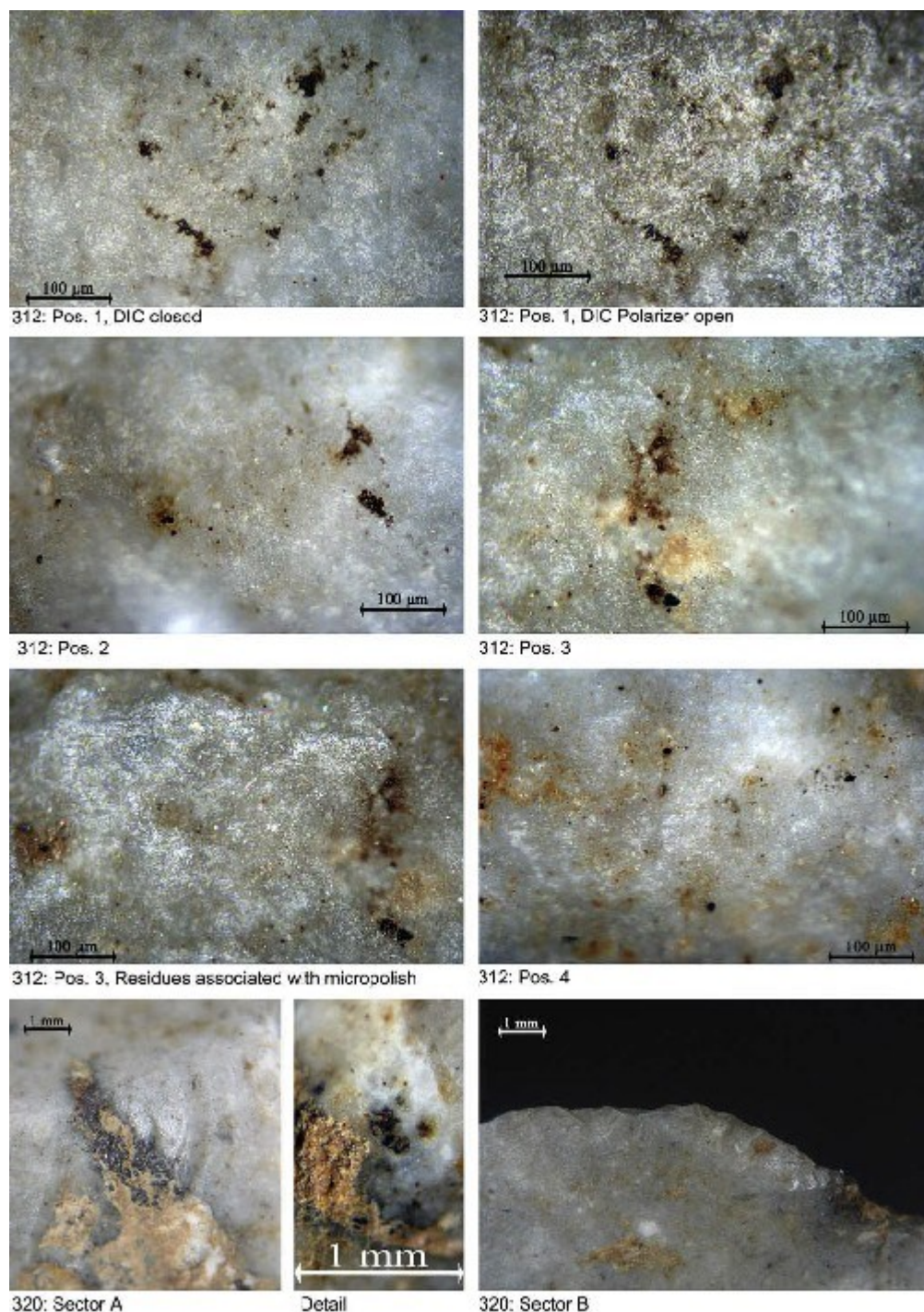


Figure 7 Residues, use-wear and hafting traces on Va1c2 312 and Va2c2 320.

See Figure 3 (middle). Numerous residues cover the proximal retouch of the artefact's edge (Fig. 3, sector B: Fig. 5g,h). As with Va2c2 309 they also appear to be the remains of hafting mastic. S-shaped transverse and torsion fractures have removed part of the distal end and truncated the burin tip (Fig. 3, sector A: Fig. 5f) and are the result of a hard frontal impact. Again, no polish or edge wear indicative of use as an engraving tool is present at or around the burin bit. Small, shallow scars can be seen ventrally directed towards the bulb of percussion. These can result from reacting forces from a shaft during impact (Pawlik, 1997). At higher magnifications, more residue spots appear on the surface, accumulating on the proximal area of the tool, until the line AA0 (Fig. 3, pos. 1: Fig. 7a;

Fig. 3, pos. 2: Fig. 7c; Fig. 3, pos. 3: Fig. 7d). Residue spots are also present on the lateral retouch (Fig. 3, pos. 4: Fig. 7f). The residues are associated with dull polishes on the elevated parts of the micro-topography (Fig. 3, pos. 1: Fig. 7b; Fig. 3, pos. 3: Fig. 7e). Again, the combination and positioning of micro-polishing and residues are good evidence that the artefact was hafted.

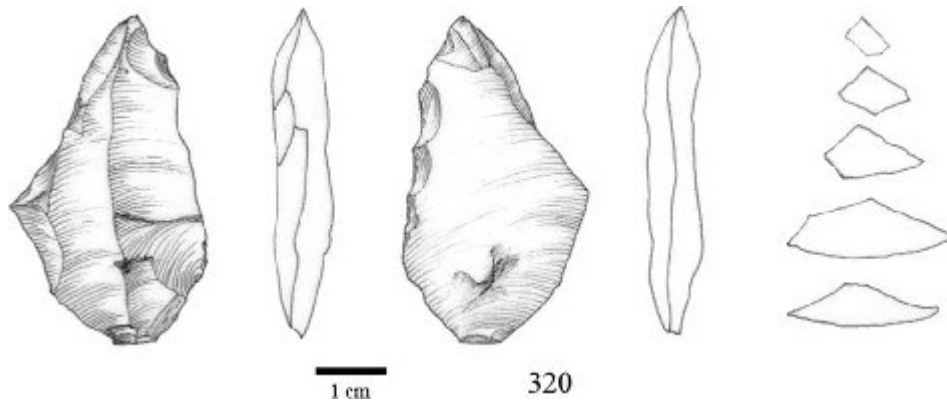


Figure 8 Va2c2 320: Dorsal, ventral and profile views. Cross-sections as in Fig. 2. Illustration by Angeliki Theodoropoulou. This artefact is also figured in Perpe`re (1977: 394), and is described by her as a “burin des Vachons distal sur petit éclat mince”.

### 5.3. Va2c2 320

See Fig. 8. Given its techno-morphological similarity to Va2c2 309 (compare Figs. 2 and 8), the description of that artefact (above) adequately describes this also. The main difference between the two artefacts is the presence of less invasive ventral retouch down the left hand margin (ventral view). The similarity in gross morphology of Va2c2 320 and Va2c2 309 suggests that this differential aggressiveness of retouch may relate to a desire for a consistent artefactual shape.

See Fig. 3 (bottom). Areas of residue are found in considerable quantity along the left lateral edge on the dorsal face (Fig. 3, sector A: Fig. 7g,h). Under the reflected-light microscope the bubbly structure of the residue, typical of weathered pitch, becomes visible (Fig. 3, pos. 2: Fig. 9g). Smaller residue spots can be found scattered on the entire proximal area of the tool. An irregular edge retouch and scarring along the proximal parts of both lateral edges (Fig. 3, sector B: Fig. 7i; Fig. 3, sector C: Fig. 9a) seem to be use-related. The edge appears abraded and blunt along sector D (Fig. 9c) while small and steep scars with distal feather- and step-cross-sections have serrated the edge of sector D (Fig. 9h). Associated with the edge scars are residues (Fig. 9b). These features are again consistent with the artefact having been hafted.

Frontal scars and glossy superficial striations appear at the tip on the dorsal surface (Fig. 3, sector E: Fig. 9d,e) as well as deeper striations slightly further away from the tip (Fig. 3, pos. 1: Fig. 9f). The immediate tip shows frontal micro-fractures, mostly with distal step cross-section (Fig. 10a,b), while longitudinal scars occur on the burin facet (Fig. 3, sector F: Fig. 10c). Together, these features provide good evidence of a frontal impact, consistent with an artefact’s use as a weapon tip (e.g. see Lombard, 2005b: 116). As with the other two artefacts presented here, the burin bit does not show any micro-wear patterns indicative of use as an engraving tool. Some sediment particles are embedded in the residue and cell structures and fragmented cell remains are visible (Fig. 10h).



The spectrum of elements acquired from several residue samples through EDX analysis shows a significant peak for carbon, verifying the organic nature of the samples (Fig. 11). Trace elements were detected: potassium (K), calcium (Ca) and sulphur (S) as well as iron (Fe), aluminium (Al), sodium (Na) and magnesium (Mg). The latter elements very likely originate from the sediment. More significant is the presence of Ca, K and S. These elements have been shown to exist in considerable quantities (as well as in the EDX histograms) in birch pitch found on artefacts from the Neolithic site of Burgäschisee-Süd and the Mesolithic site of Henauhof-Nord II (Pawlik, 1995: 199-201). Likewise, EDX of experimentally created birch pitch indicated the presence of Ca and K (Pawlik, 1995: 202). It was then concluded that these elements derived from exposure to fire and ash during processing and use.

The residues on the artefacts presented here show strong similarity to and display the same characteristics as the aforementioned samples from the Mesolithic and Neolithic. There, the origin birch bark had partly turned into pitch while primary plant material still remained.

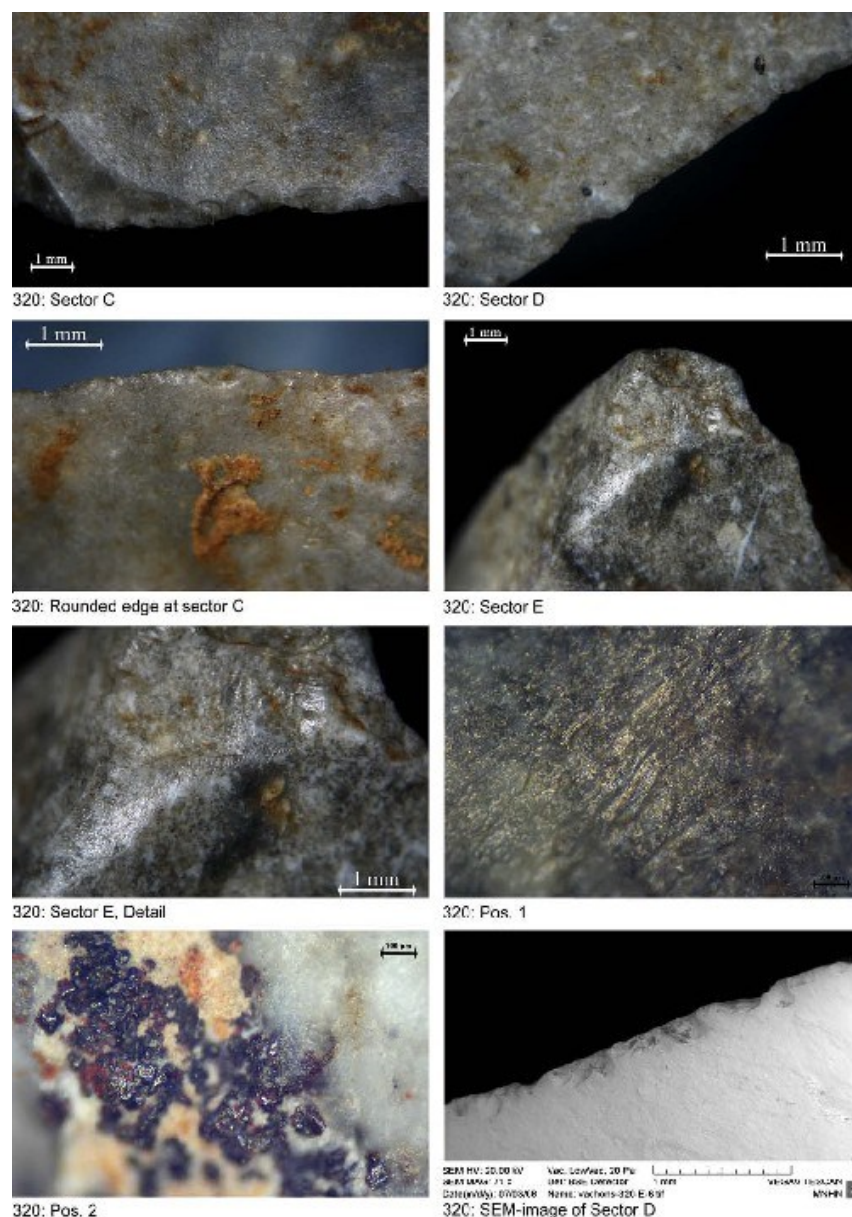


Figure 9 Micro-wear traces and residues on Va2C2 320.

## 6. Summary and conclusions

Our results confirm the conclusion of previous studies (Arrighi et al., 2006; Chiotti, 2005: 251) in that Aurignacian carinated burins understood techno-typologically as discarded cores from the production of bladelets were also sometimes utilised as tools. More generally, this study concurs with the largest use-wear analysis of Aurignacian lithic material to date (Hardy et al., 2008); the ultimate function(s) of lithic artefacts cannot be determined securely from techno-typological presupposition (whether this is technologically demonstrated or techno-typologically inferred). The implications of this with regard to broad syntheses of behaviour based upon archaeologically observed lithic artefact form are obvious.

Analyses presented here show clearly that all three artefacts studied were the functionally active part of a composite technology that would have included a shaft, a haft that incorporated birch pitch as mastic and the stone artefact. This hafting mastic would have been strong, easy to maintain and even recyclable. The location of hafting residues and associated micro-wear traces indicate a basal hafting encompassing at least the proximal half of all three artefacts. The visible structure of the residues has a high similarity to previously identified birch pitch on hafted tools from the Neolithic, Mesolithic, Upper and Middle Palaeolithic. With birch pitch now identified on (Early Upper Palaeolithic) Aurignacian artefacts this hafting process represents a technological continuity within Europe from the Middle Palaeolithic to the Neolithic. In light of the similarity of the microscopic structure of the pitch (described above) recognised from these different periods it can be postulated that a similar method of procurement and distillation was used throughout. Certainly humans during these periods had the knowledge to identify the source of this material and the skill to successfully extract and use it.

Given the nature of use-wear traces evident on the unhafted (distal) section of the artefacts, we suggest that at least two of them (Va2c2 309 and Va2c2 320 – Figs. 2 and 8) were used as weapon tips. Morphologically, the cross-section at and close to their tips has been rendered rounded due to both dorsal and ventral removals. Although much more irregular on these lithic artefacts, a rounding is also apparent on distal cross-sections of osseous points from the Aurignacian and elsewhere in the Upper Palaeolithic (e.g. see Leroy-Prost, 1979: 251; Vercoutère, 2004: Pl. VIII d). The retouched concavity on their left margin (in dorsal view) may have aided their secure hafting. Our analyses indicate that they were not used as engraving tools. Instead, use-wear features present are consistent with dynamic frontal forces at the distal point: impact damage at– and striations radiating away from– the tip. With regard to the use of ‘burin’ removals to shape the tip of a weapon point, an ethnographic study by Witthoft (1968) describes the burin blow technique as “... a common method of repointing projectile points when a broken tip was repaired in the field”. It is also known that elongated burin-like removals were sometimes applied to resharpen Middle Palaeolithic bifaces (Wragg Sykes, in preparation). It is hoped that future work will allow replicas of these two artefacts to be hafted and their potential use(s), including as weapon tips, explored.

The third artefact (Va1c2 312 – Fig. 6) is more difficult to interpret. Its present morphology makes interpretation as a weapon tip unfeasible. Macroscopic analysis indicates that part of its distal morphology results from a frontal impact. However, the last technological action on the artefact is a removal whose scar is reminiscent of the creation of a long, regular bladelet. Complete lack of microscopic distal use-wear traces therefore suggests that it may have been broken and then reworked before being discarded. Further clues to its precise function are thus lost. It is certainly not inconceivable that all three artefacts served the same function when hafted.

Due to the antiquity of the excavations at Les Vachons and the subsequent history of the collections the artefacts analysed in this study are presumed to have been bladelet cores on account of their techno-morphology. Any attempt to refit *débitage* to these particular artefacts would be bound to

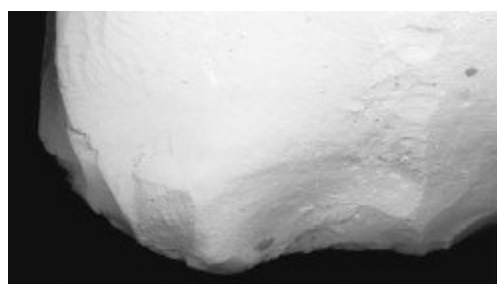


fail. It is known that some unretouched material from the site was discarded as unimportant during the initial excavations (A. Fontaine, personal communication) and very few small lithic pieces remain in the collection (RD, personal observation). Without this refitting, it is impossible to demonstrate securely that these particular artefacts were reduced with this aim. However, technological similarities between accepted bladelet core artefact types, particularly *burins busqués* and *burins des Vachons sensu* Pesesse and Michel (2006), are good circumstantial evidence that these three artefacts served a similar function.

It is plausible that the artefacts described here were created and rejuvenated— perhaps while in the haft— using the same reduction method as was used more commonly for the production of bladelets. This reduction sequence may therefore have served both to create (and renew?) the tip of the artefact and to provide useable *débitage*.

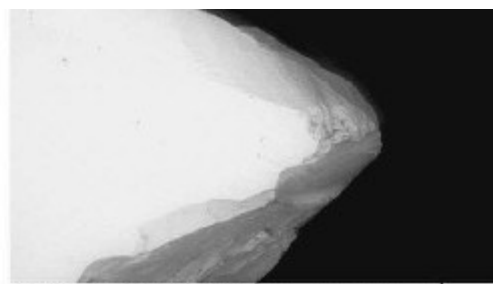
What is readily apparent from these analyses is that the relationship between lithic techno-typology and function is complex. A reduction sequence approximating the technological reduction sequence of burin des Vachons bladelet creation is visible on two of the artefacts presented here (Va2c2 309 and Va2c2 320). Indeed, one example (Va2c2 320) has been described previously as a burin des Vachons (Perpère, 1977: 394; see Fig. 8). Our analyses demonstrate that this reduction also served a more primary role than the production of bladelets; to shape the active part of a hafted artefact. This serves as a reminder of the complexity of use of lithic resources in the Early Upper Palaeolithic and the problems inherent in inferring the function of artefacts using techno-typological analysis alone.

Finally, the authors would like to draw attention to the often overlooked potential of old collections. Despite the collection's long curatorial history, micro-wear analysis on a portion of our chosen sample was successful and the presence of significant traces of hafting residue on the artefacts is testament to the information artefacts from old collections can yield. The authors also hope that this study highlights the potential for hafting residues to be present on Aurignacian artefacts. We would urge Palaeolithic archaeologists to implement suitable post-excavation controls (specifically with regard to the handling and cleaning of material) to ensure that such residues are not lost.



SEM HV: 20.00 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 50 x Det: BSE Detector 1 mm  
Date/Time: 07/03/08 Name: vachon-320-F-3.tif  
VEGA TESCAN MNH

320: Frontal scars on the tip



SEM HV: 20.00 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 81 x Det: BSE Detector 1 mm  
Date/Time: 07/03/08 Name: vachon-320-E.tif  
VEGA TESCAN MNH

320: frontal micro-scarring



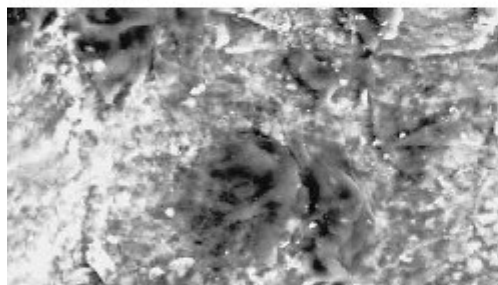
SEM HV: 20.00 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 81 x Det: BSE Detector 1 mm  
Date/Time: 07/03/08 Name: vachon-320-F-3.tif  
VEGA TESCAN MNH

320: Impact scar



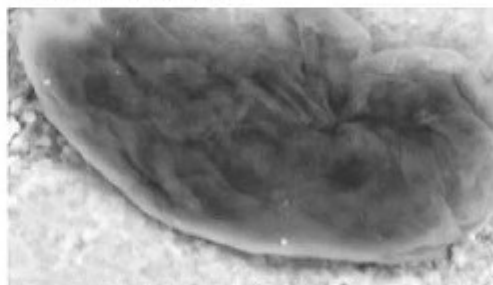
SEM HV: 20.04 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 124 x Det: BSE Detector 500 µm  
Date/Time: 07/02/08 Name: vachon-312-pos-1-6.tif  
VEGA TESCAN MNH

312: Residue on tool surface



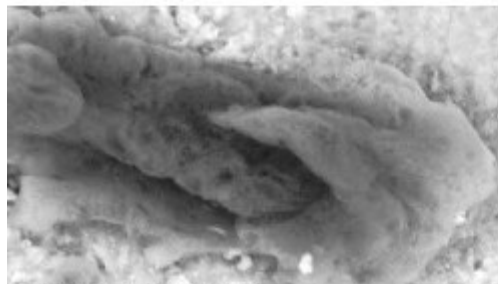
SEM HV: 20.00 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 2.15 kx Det: BSE Detector 20 µm  
Date/Time: 07/03/08 Name: vachon-320-E-4.tif  
VEGA TESCAN MNH

320: Morten plant remains in the residue



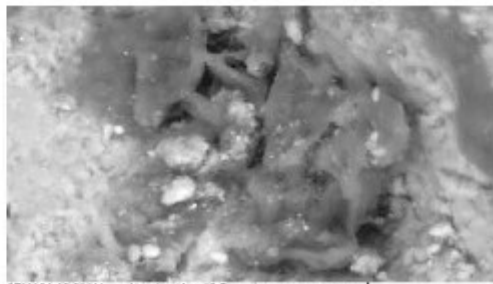
SEM HV: 20.06 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 1.55 kx Det: BSE Detector 50 µm  
Date/Time: 07/03/08 Name: vachon-312-pos-1-4.tif  
VEGA TESCAN MNH

312: Plant remains embedded in amorphous pitch matrix



SEM HV: 20.03 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 2.08 kx Det: BSE Detector 50 µm  
Date/Time: 07/03/08 Name: vachon-312-pos-1-7.tif  
VEGA TESCAN MNH

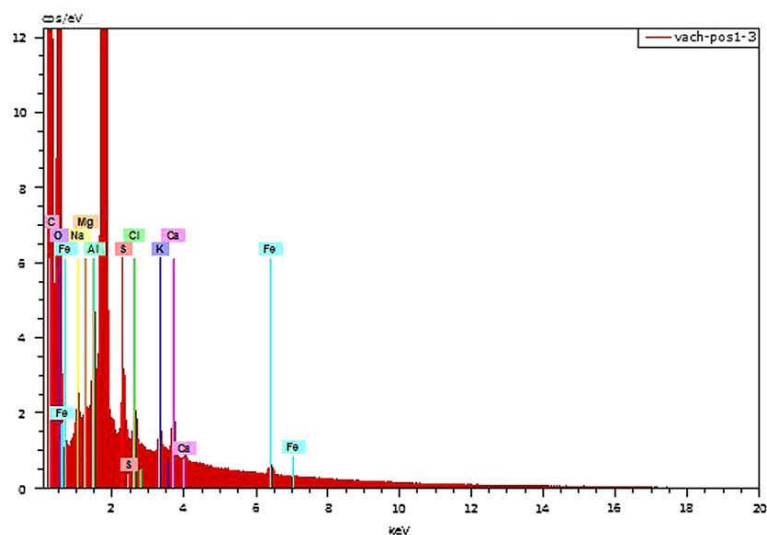
312: Partially transformed birch bark frazzles and fibres



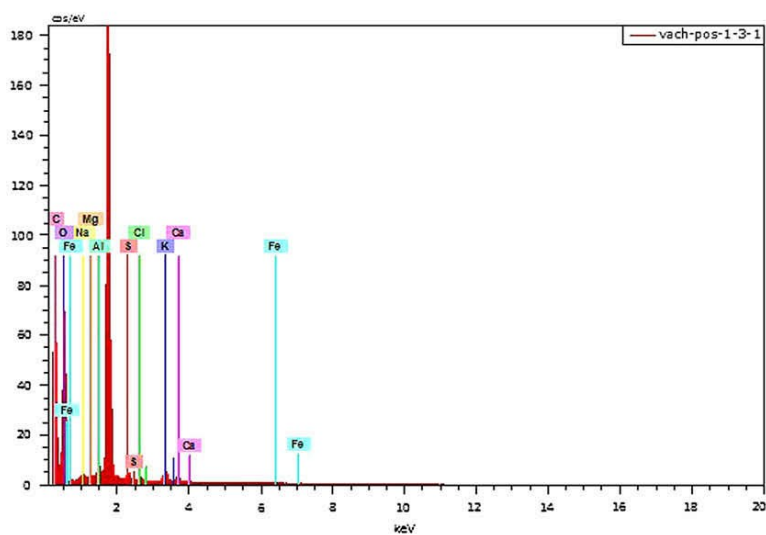
SEM HV: 20.04 kV Vac: Low/Vac: 20 Pa  
SEM MAG: 2.47 kx Det: BSE Detector 20 µm  
Date/Time: 07/03/08 Name: vachon-320-E-6.tif  
VEGA TESCAN MNH

320: Plant cell structures in the pitch residue.

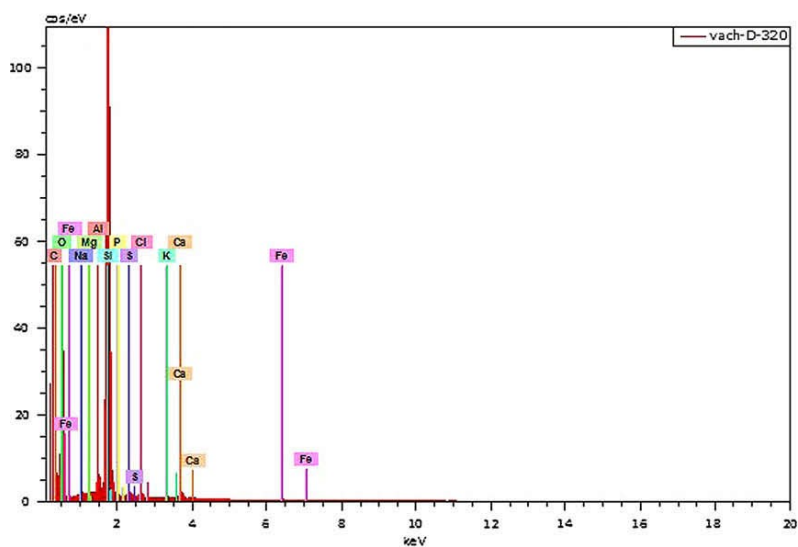
Figure 10 SEM images of impact wear traces and birch pitch residues.



EDX-histogram of residue on Va2c2 312



EDX-histogram of residue on Va2c2 312



EDX-histogram of residue on Va2c2 320

Figure 11 EDX-histograms of birch pitch residues on Va1c2 312 and Va2c2 320.

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## References

- Anderson, P., 1980. A testimony of prehistoric tasks: diagnostic residues on stone tool working edges. *World Archaeology* 12 (2), 81–194.
- Arrighi, S., Borgia, V., Moroni Lanfredini, A., Ronchitelli, A., 2006. Burins des Vachons en Italie: typologie, morphotechnique et tracéologie, in: Bracco, J.-P., De Araujo Igreja, M., Le Brun-Ricalens, F. (Eds.), *Burins Préhistoriques: Formes, Fonctionnements, Fonctions: Actes de la Table-Ronde d'Aix-en-Provence (3–5 Mars 2003)*. Luxembourg, *Archéologiques* 2, 103–118.
- Baales, M., 2002. Der spätpaläolithische Fundplatz Kettig. RGZM 51.
- Barton, R.N.E., Bergman, C.A., 1982. Hunting at Hengistbury: some evidence from experimental archaeology. *World Archaeology* 14, 237–248.
- Bordes, J.-G., 2006. News from the West: a reevaluation of the classical Aurignacian sequence of the Périgord. In: Bar-Yosef, O., Zilhão, J. (Eds.), *Towards a Definition of the Aurignacian*. Instituto Português de Arqueologia, Lisbon, pp. 147–171. *Trabalhos de Arqueologia* 45.
- Bouyssonie, J., 1948. Un gisement aurignacien et périgordien, Les Vachons (Charente). *L'Anthropologie* 52, 1–42.
- Bouyssonie, J., de Sonnevile-Bordes, D., 1956. L'abri no. 2 des Vachons, gisement aurignacien et périgordien, commune de Voulgézac (Charente). *Congrès Pré-historique de France, XV<sup>e</sup> session. Poitiers-Angoulême 1956*, 271–309.
- Chiotti, L., 2000. Lamelles Dufour et grattoirs aurignaciens (carénés et à museau) de la couche 8 de l'abri Pataud, Les Eyzies-de-Tayac, Dordogne. *L'Anthropologie* 104, 239–263.
- Chiotti, L., 2003. Les productions lamellaires dans l'Aurignacien de l'Abri Pataud, Les-Eyzies-de-Tayac. *Gallia Préhistoire* 45, 113–156.
- Chiotti, L., 2005. Les industries lithiques aurignaciennes de l'Abri Pataud, Dordogne, France: les fouilles de Hallam L. Movius Jr. Oxford, BAR International Series 1392.
- Conard, N.J., Bolus, M., 2003. Radiocarbon dating the appearance of modern humans and timing of cultural innovations in Europe: new results and new challenges. *Journal of Human Evolution* 44, 331–371.
- Davies, W., 2001. A very model of a modern human industry: new perspectives on the origins and spread of the Aurignacian in Europe. *Proceedings of the Prehistoric Society* 67, 195–217.
- Dinnis, R., 2008. On the technology of late Aurignacian burin and scraper production, and the importance of the Paviland lithic assemblage and the Paviland burin. *Lithics: The Journal of the Lithic Studies Society* 29, 18–35.
- Dujardin, V., 2005. Débitage lamellaire aurignacien à la Quina Aval (Gardes-le-Pontaroux) et à la Grotte des Renardières (Les Pins, Charente, France). In: Le Brun-Ricalens, F., Bordes, J.-G., Bon, F. (Eds.), *Productions Lamellaires Attribuées à l'Aurignacien: Chaînes Opératoires et Perspectives Techno-culturelles. Actes de la Table-ronde organisée dans le cadre du XV<sup>e</sup> Congrès de l'UISPP, Liège, 2001*. *Archéologiques* 1, Luxembourg, pp. 273–295.

- Fischer, A., Vemming Hansen, P., Rasmussen, P., 1984. Macro and micro wear traces on lithic projectile points: experimental results and prehistoric examples. *Journal of Danish Archaeology* 3, 19–46.
- Flas, D., Miller, R., Jacobs, B., 2006. Les “burins” de l’Atelier de débitage aurignacien de Maisières-Canal (Province du Hainaut, Belgique). In: Bracco, J.-P., De Araujo Igreja, M., Le Brun-Ricalens, F. (Eds.), *Burins Préhistoriques: Formes, Fonctionnements, Fonctions, Actes de la Table-Ronde d’Aix-en-Provence (3–5 Mars 2003)*. ArchéoLogiques 2, Luxembourg, pp. 55–74.
- Fullagar, R. (Ed.), 1998. *A Closer Look, Recent Australian Studies of Stone Tools*. Sydney University Archaeological Methods Series 6.
- Gechter-Jones, J., Pawlik, A., 1998. Ein absolut datiertes Mehrzweckgerät der frühen Bronzezeit: Feuerschläger und Meissel. *Archäologie im Rheinland* 1997, 33–35.
- Geneste, J.-M., Plisson, H., 1993. Hunting technologies and human behaviour: lithic analysis of Solutrean shouldered points. In: Knecht, H., Pike-Tay, A., White, R. (Eds.), *Before Lascaux: The Complex Record of the Early Upper Palaeolithic*. CRC Press, Boca Raton, pp. 117–135.
- Grünberg, J.M., 2002. Middle Palaeolithic birch-bark pitch. *Antiquity* 76, 15–16.
- Hardy, B.L., Garufi, G.T., 1998. Identification of woodworking on stone tools through residue and use-wear analyses: experimental results. *Journal of Archaeological Science* 25 (2), 177–185.
- Hardy, B.L., Kaye, M., Marks, A.E., Monigal, K., 2001. Stone tool function at the Palaeolithic sites of Starosele and Buran Kaya III, Crimea: behavioural implications. *Proceedings of the National Academy of Science* 98 (19), 10972–10977.
- Hardy, B.L., Bolus, M., Conard, N.J., 2008. Hammer or crescent wrench? Stone-tool form and function in the Aurignacian of southwest Germany. *Journal of Human Evolution* 54, 648–662.
- Haslam, M.A., 2006. *Archaeological residue and starch analysis. Interpretation and taphonomy*. School of Social Science, PhD thesis, University of Queensland.
- Hayden, B. (Ed.), 1979. *Lithic Use Wear Analysis*. Academic Press, New York.
- Hays, M.A., Lucas, G., 2001. Experimental investigations of Aurignacian Dufour Bladelets. In: Hays, M.A., Thacker, P.T. (Eds.), *Questioning the Answers: Re- solving Fundamental Problems of the Early Upper Paleolithic*. BAR International Series 1005, Oxford, pp. 109–117.
- Jacobi, R., Pettitt, P.B., 2000. An Aurignacian point from Uphill Quarry, Somerset, and the colonisation of Britain by *Homo sapiens*. *Antiquity* 74, 513–518.
- Kamminga, J., 1977. A functional study of use-polished eloueras. In: Wright, R. (Ed.), *Tools as Cultural Markers. Prehistory and Material Culture Series 12*, Australian Institute of Aboriginal Studies, Canberra, pp. 205–212.
- Keeley, L.H., 1980. *Experimental Determination of Stone Tool Uses*. University of Chicago Press.
- Keeley, L.H., 1982. Hafting and retooling: effects in the archaeological record. *American Antiquity* 47, 798–809.
- Kind, C.-J., 1997. *Die letzten Wildbeuter. Henauhof Nord II und das Endmesolithikum in Baden-Württemberg. Materialhefte zur Archäologie in Baden-Württemberg* 39.
- Koller, J., Baumer, U., Mania, D., 2001. High-tech in the Middle Palaeolithic: Neandertal manufactured pitch identified. *European Journal of Archaeology* 4 (3), 385–397.
- Le Brun-Ricalens, F., Bordes, J.-G., Bon, F. (Eds.), 2005. *Productions Lamellaires attribuées à l’Aurignacien: chaînes opératoires et perspectives techno-culturelles. Actes de la Table-ronde organisée dans le cadre du XVe Congrès de l’UISPP, Liège, 2001*. ArchéoLogiques 1, Luxembourg.
- Le Brun-Ricalens, F., Bracco, J.P., Brou, L., 2006. Burins carénés, grattoirs carénés et formes associées: un retournement!. In: Bracco, J.-P., De Araujo Igreja, M., Le Brun-Ricalens, F. (Eds.), *Burins Préhistoriques: Formes, Fonctionnements, Fonctions: Actes de la Table-Ronde d’Aix-en-Provence (3–5 Mars 2003)*. Archéologiques 2, Luxembourg, pp. 345–356.
- Leroy-Prost, C., 1979. L’industrie osseuse aurignacienne. Essai régional de classification: Poitou, Charentes, Périgord. *Gallia Préhistoire* 22 (1), 205–370.
- Lombard, M., 2005a. Evidence for hunting and hafting during the Middle Stone Age at Sibudu Cave, Kwa-Zulu-Natal, South Africa: a multi-analytical approach. *Journal of Human Evolution* 48, 279–300.
- Lombard, M., 2005b. A method for identifying Stone Age hunting tools. *South African Archaeological Bulletin* 60 (182), 115–120.
- Lombard, M., Pargeter, J., 2008. Hunting with Howiesons Poort segments: pilot experimental study and the functional interpretation of archaeological tools. *Journal of Archaeological Science* 35, 2523–2531.
- Loy, T.H., 1983. Prehistoric blood residues: detection on tool surfaces and the identification of species of origin. *Science* 220, 1269–1271.
- Loy, T.H., 1990. Prehistoric organic residues: recent advances in identification, dating and their antiquity, in: Wagner, W., Pernicka, E. (Eds.), *Archaeometry ’90: Proceedings of the 27th International Symposium on Archaeometry, Heidelberg*, pp. 645–656.

- Lucas, G., 1997. Les Lamelles Dufour du Flageolet I (Bézenac, Dordogne) dans le contexte aurignacien. *Paléo* 9, 191–220.
- Mazza, P., Martini, F., Sala, B., Magi, M., Colombini, M., Giachi, G., Landucci, F., Lemorini, C., 2006. A new Palaeolithic discovery: tar-hafted stone tools in a European Mid-Pleistocene bone-bearing bed. *Journal of Archaeological Science* 33, 1310–1318.
- Mellars, P., 2005. Neanderthals and the modern human colonization of Europe. *Nature* 432, 461–465.
- Odell, G.H., Odell-Verwey, F., 1980. Verifying the reliability of lithic use wear assessments by “blind tests”: The low power approach. *Journal of Field Archaeology* 7, 87–120.
- Otte, M., 1979. Le Paléolithique Supérieur Ancien en Belgique. Monographies d’Archeologie Nationale 5. Musées Royaux d’Art et d’Histoire, Brussels.
- Palmer, F., 2007. Die Entstehung von Birkenpech in einer Feuerstelle unter paläolithischen Bedingungen. *Mitteilungen der Gesellschaft für Urgeschichte* vol. 16, 75–83. Tübingen.
- Pawlik, A., 1992. Mikrogebrauchsspurenanalyse. Methoden – Forschungsstand – Neue Ergebnisse. *Urgeschichtliche Materialhefte* 9. Tübingen, Archaeologica Venatoria.
- Pawlik, A., 1995. Die mikroskopische Analyse von Steingeräten. Experimente – Auswertungsmethoden – Artefaktanalyse. *Urgeschichtliche Materialhefte* 10. Tübingen, Archaeologica Venatoria.
- Pawlik, A., 1997. Funktionsanalyse an Artefakten aus Henauhof Nord II, in: Kind, C.-J., Die letzten Wildbeuter. Henauhof Nord II und das Endmesolithikum in Baden-Württemberg. *Materialhefte zur Archäologie in Baden-Württemberg* 39, 150–178.
- Pawlik, A., 2004a. Identification of hafting traces and residues by scanning electron microscopes and energy-dispersive analysis of X-rays. In: Walker, E.A., Wenban-Smith, F., Healy, F. (Eds.), *Lithics in Action: Papers from the Conference “Lithic Studies in the Year 2000”*. Oxbow Books, Oxford, pp. 172–183.
- Pawlik, A., 2004b. An Early Bronze Age pocket lighter. In: Walker, E.A., Wenban-Smith, F., Healy, F. (Eds.), *Lithics in Action: Papers from the Conference “Lithic Studies in the Year 2000”*. Oxbow Books, Oxford, pp. 149–151.
- Pawlik, A., Thissen, J., 2008. Birkenpechgewinnung und Rentierjagd im Indetal. *Archäologie im Rheinland* 2007, 41–44.
- Perpère, M., 1972. Les burins aurignaciens du gisement des Vachons (Charente). *Congrès Préhistorique de France*, 19th session. Auvergne, 320–323.
- Perpère, M., 1977. L’industrie des Vachons et l’Aurignacien en Poitou-Charentes. *L’Anthropologie* 81, 377–410.
- Pesesse, D., Michel, A., 2006. Le burin des Vachons: apports d’une relecture technologique à la compréhension de l’Aurignacien récent du nord de l’Aquitaine et des Charentes. *Paléo* 18, 143–160.
- Pettitt, P.B., 2008. The British Upper Palaeolithic. In: Pollard, J. (Ed.), *Prehistoric Britain*. Blackwell Studies in Global Archaeology, London, pp. 18–57.
- Plisson, H., 1985. Etude fonctionnelle des outillages lithiques préhistoriques par l’analyse des micro-usures, recherche méthodologique et archéologique. Thèse de doctorat, Université de Paris I.
- Rots, V., 2003. Towards an understanding of hafting: the macro- and microscopic evidence. *Antiquity* 77, 805–815.
- Rots, V., Williamson, B.S., 2004. Microwear and residue analyses in perspective: the contribution of ethnoarchaeological evidence. *Journal of Archaeological Science* 31, 1287–1299.
- Rottländer, R.C.A., 1991. Untersuchungen an der Kittmasse von geschäfteten Feuersteinklingen. In: Waterbolk, H.T., van Zeist, W. (Eds.), *Niederwil, eine Siedlung der Pfyn-Kultur. IV Holzartefakte und Textilien*. Academia Helvetica I/IV, Bern, pp. 249–250.
- Schäfer, D., Holdermann, C., Pawlik, A., Affolter, J., Iking, A., Bertola, S., 2006. Meso-lithic subsistence at Ullafelsen/Tyrol. Preliminary studies 1995–2002. In: Kind, C.-J. (Ed.), *After the Ice Age. Settlements, Subsistence and Social Development in the Mesolithic of Central Europe*. *Materialhefte zur Archäologie* 78, pp. 201–210.
- Semenov, S.A., 1964. *Prehistoric Technology*. Adams and Dart, Bath.
- Shea, J.J., 1988. Spear points from the Middle Palaeolithic of the Levant. *Journal of Field Archaeology* 15, 441–450.
- Stringer, C., 2006. *Homo Britannicus: The Incredible Story of Human Life in Britain*. Penguin, London.
- Torrence, R., Barton, H. (Eds.), 2006. *Ancient Starch Research*. Left Coast Press Inc., California.
- Unrath, G., 1982. Die Funktionsbestimmung geschlagener Steinwerkzeuge anhand ihrer mikroskopisch erkennbaren Gebrauchsspuren. Unpublished Master’s thesis, Universität Tübingen, Institut für Urgeschichte.

- Unrath, G., Owen, L.R., van Gijn, A., Moss, E.H., Plisson, H., Vaughan, P., 1986. An evaluation of micro-wear studies: a multi-analyst approach. In: Unrath, G., Owen, L. (Eds.), *Technical Aspects of Micro-wear Studies on Stone Tools*, Early Man News 9/10/11. Archaeologica Venatoria, Tübingen.
- Vaughan, P., 1985. *Use-wear Analysis on Flaked Stone Tools*. University of Arizona Press.
- Vercoutère, C., 2004. Utilisation de l'animal comme ressource de matières premières non alimentaires: industrie osseuse et parure. Exemple de l'abri Pataud (Dordogne, France). Unpublished PhD thesis, Muséum National d'Histoire Naturelle, Département de Préhistoire, Institut de Paléontologie Humaine.
- Weiner, J., 1988. Praktische Versuche zur Herstellung von Birkenpech. *Archäologisches Korrespondenzblatt* 18, 329–334.
- Weiner, J., 1991. Wo sind die Retorten? Überlegungen zur Herstellung von Birkenpech im Neolithikum. *Acta Praehistorica et Archaeologica* 23, 15–19.
- Weiner, J., 2005. Another word on pitch. Some comments on a "Sticky Issue" from Old Europe. *Bulletin of Primitive Technology* 29, 20–27.
- Witthoft, J., 1968. Flint arrowheads from the Eskimo of Northwestern Alaska. *Expedition* 10 (2), 30–37.
- Wragg Sykes, R., in preparation. *Neanderthals in Britain: Late Mousterian archaeology in landscape context*. Doctoral thesis, University of Sheffield.